Driver Focus:
A North American Perspective

Presented To The ITC

By

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February 18, 2004

A North American Perspective On A Global Issue

- In the U.S., the Alliance of Automotive Manufacturers has been working for 4 years on a set of voluntary guidelines for managing driver workload and distraction associated with telematics devices
- In that effort, we have benefited from work in Europe and Japan – and have learned that the challenge of managing driver distraction in the presence of new technologies is a global one, just as the automotive business itself has become a global one (solutions which work for the North American side of a company often must also work for their overseas divisions and for their exported products)
- Similarly, though the members of the Alliance sell their vehicles in North America, the Driver Focus guidelines have drawn upon programs of research from around the world
- And the Alliance has made a commitment to harness and apply state-of-the-art scientific understanding to the continuing evolution of its Driver Focus guidelines

Government and Industry Research Projects

- ADAM (Germany)
- DWMC (CAMP-USA)
- HASTE (EU)
- Roadsense (EU)
- Naturalistic Driving (VTTI-USA)
- JAMA (Japan)
- IHRA – ITS (Global)
- TC (Canada)
- NHTSA (USA)
- VTI (Sweden)
- TNO (Netherlands)
- VTT (Finland)
- TU Delft (Netherlands)
- AIDE (EU)
- Others…

Today's Focus

Two Of The Ongoing Research Projects Providing Input To AAM

CAMP
Driver Workload Metrics Project

(GM, Ford, Nissan, Toyota)

ADAM -
Advanced Driver Attention Metrics

(DCX & BMW)

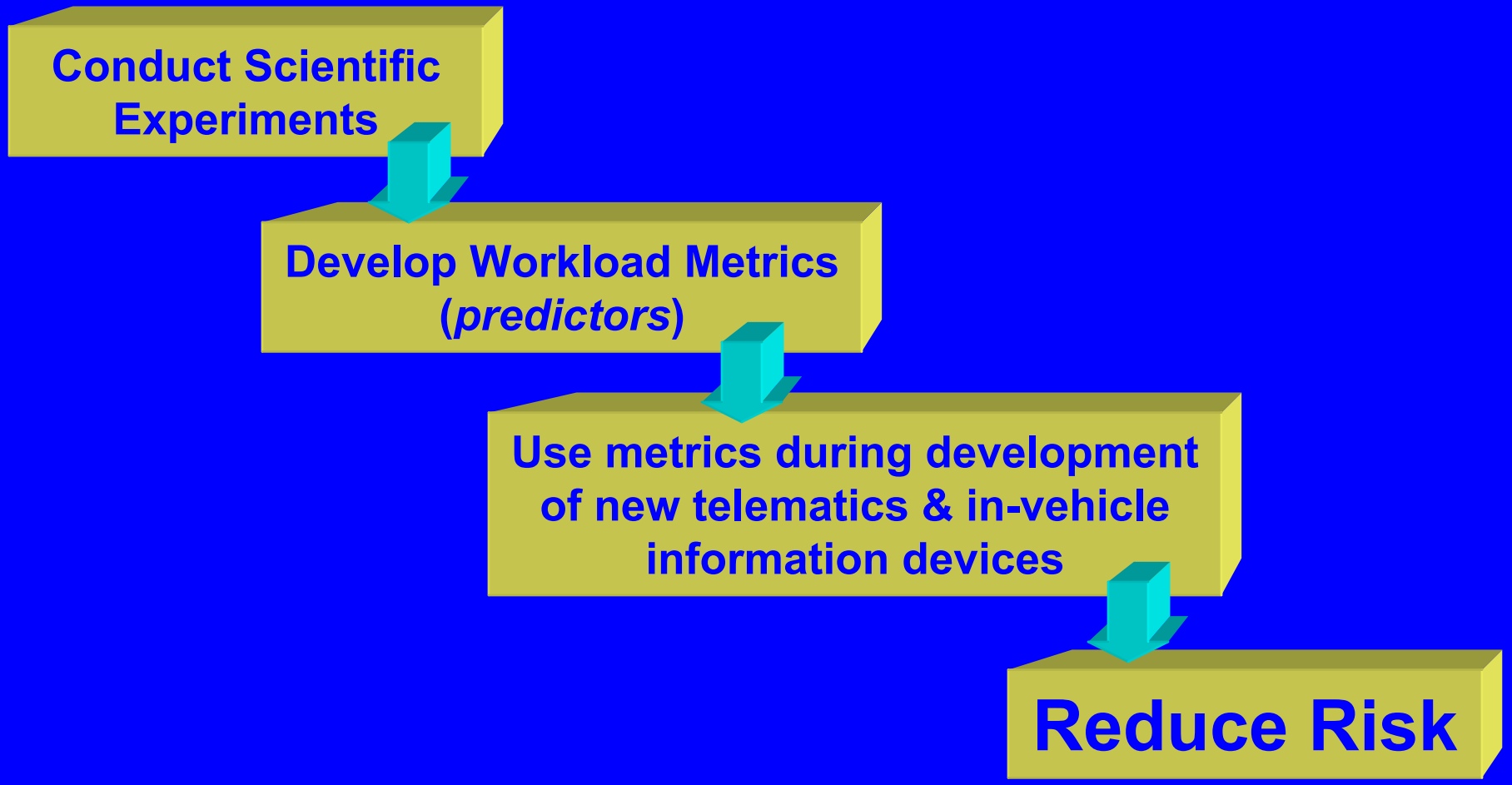
CAMP

Driver Workload Metrics Consortium

IVI Light Vehicle Enabling Research Program

Overview Of The CAMP Driver Workload Metrics Project

Concept Motivating Driver Workload Metrics Project



CAMP

Driver Workload Metrics Consortium

IVI Light Vehicle Enabling Research Program

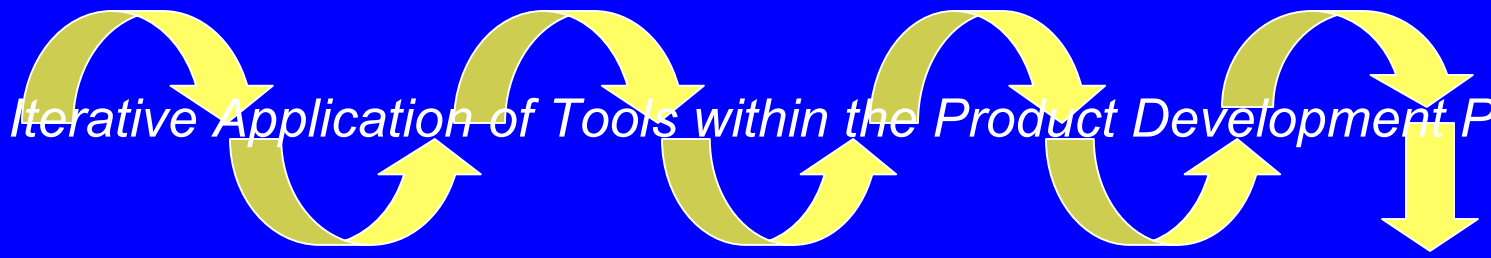
Project Objective

- To develop ***performance metrics and test procedures*** for assessing the ***visual, manual and cognitive aspects*** **of** ***driver workload*** from telematics systems.
  - In this development effort, the project is investigating both:
    - '***Driving performance measures'*** of driver workload taken under test track and on-road driving conditions as well as
    - '***Surrogate metrics'*** which include models, simulations or laboratory procedures.
  - A major goal is to assemble ***practical tools*** for product development & evaluation that valid and reliable.

Surrogate Metric Selection

Surrogate metrics can be used iteratively through product development to manage driver workload implications of new systems

Pre-Prototype Phase	Bench Interactive Prototype Phase	Mockup & Pre-Production Prototypes



Surrogate (Analytic) Tools For This Phase:

- Count of Task Steps
- IVIS DEMAnD Model
- GOMS Model
- Modified MRT Model

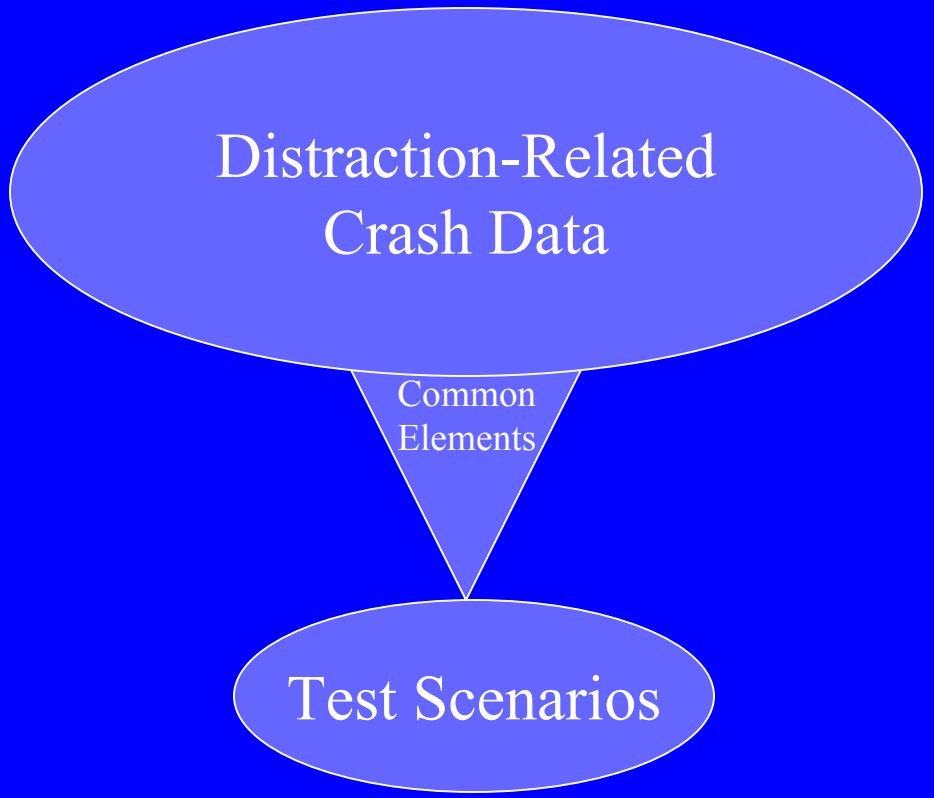
Surrogate (Testing) Tools For This Phase:

- Static (Single Task) Method
  - Task Completion Time
  - Visual Occlusion Metrics
- Static (Multitask) Method
  - Driving Simulator Measures
  - Peripheral Detection Task Metrics
  - Sternberg Paradigm Measure
  - Task Completion Time
  - Rated Situation Awareness
  - Rated Workload

Surrogate (Testing) Tools For Confirmation/Validation Phase:

- Dynamic Drive Testing Methods
  - Peripheral Detection Task
  - Rated Situation Awareness
  - Rated Workload

Test Scenario Development



1. Studies of distraction-related crash data were reviewed
2. Common characteristics of these crashes were identified
3. Test scenarios were formulated on the basis of these

Driving Scenarios Defined For This Project

- On-Road Scenario
  - Semi-naturalistic car following
  - Daylight, level, straight
  - Dry pavement, clear weather conditions
  - Speed ~ 55 mph (varying between 45 and 65 mph)
  - Visual events to be detected

- Test Track Scenario
  - Same (though implemented on large oval track)

Experimental Approach

- Phased testing of 234 test participants
  (increased from originally-planned sample of 120)
  - Males and Females ranging from 21 to 79 years of age
  - All measured for selected individual capacities; abilities; skills

- Each participant was tested in one of three settings:
  - On-the-road (using instrumented vehicles) (Sample Size = 108)
  - On a test track (using instrumented vehicles) (Sample Size = 69)
  - In the lab (using surrogate methods) (Sample Size = 57)

- In each setting, participants were asked to perform a variety of in-vehicle tasks (after having been trained on them)

- Repeated measurements of each task were taken on each metric

Tasks Were Selected To:

- Span the range of difficulty (or potential to interfere with driving, from low to high)
- Span prominent interface types, functionalities and known effects
- Represent all meaningful combinations of task demands on driver resources
  - » Input Modality (Visual, Auditory)
  - » Working Memory (Spatial, Verbal)
  - » Output Modality (Manual, Vocal)

Resulting Task Set

Included a wide range of tasks:

- **Current/Conventional Tasks:**

  Traditional in-vehicle tasks (e.g., radio tuning, HVAC adjust, sports broadcast, book-on-tape, conversation)

- **Comparison Tasks:**

  Other in-vehicle tasks (e.g., cell phone dialing, CD insert, cassette insert)

- **Artificial Tasks:**

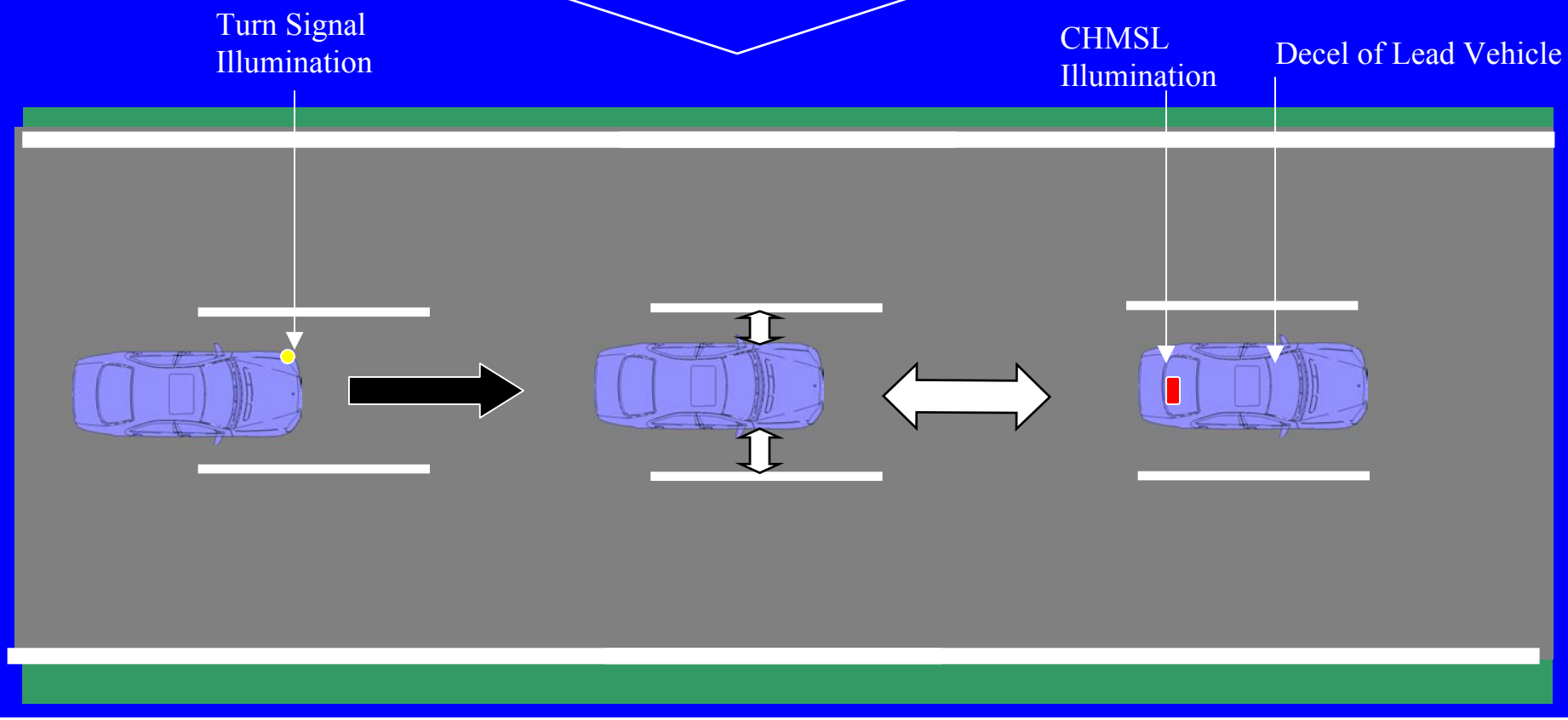
  Special purpose tasks (e.g.,mental arithmetic like trip computations, memory tasks like remembering route instructions)

- **New and Emerging Tasks:**

  Telematics-based tasks (e.g. navigation, reading text messages, reading maps, communications tasks)

Driving Test Approach

Three-Vehicle Platoon, with .multitasking. driver in middle vehicle (and lead/follow vehicles providing object & event detection stimuli)



Types Of Measures Used

- **Driving Performance Measure:** Measure of driver behavior or driver-vehicle performance
  - Obtained in a driving context
  - Thought to be safety relevant
- **Surrogate Measure:** Measure which can provide an estimate of distraction potential – or which can be used as a ***predictor*** of driver-vehicle performance
  - Can be obtained before full-scale drivable prototypes become available
  - Can be used as a ***predictor*** of one or more key measures of driving performance

Driving Performance Measures

Visual Allocation

- Glance Duration
- Number of Glances
- Glance Sequence
- Breadth of Scanning

Vehicle Control

- Lane Keeping
- Car Following
- Speed Control

Object & Event Detection

- % Missed Detections
- Latencies To Detect
- Situation Awareness

Surrogate Methods

- **Occlusion (ISO timing)**
- **STISIM Driving Simulator**
- **Peripheral Detection Task (PDT)**
  - » **Alone**
  - » **With STISIM**
- **Static Task Completion Time (J2364 Method)**
- **Subjective Assessments**
- **Other . . .**

Goggles-Occlusion Method

- Surrogate Method
  - For visual,visual-manual tasks
  - Surrogate for visual demand
  - Participant completes visual-manual task with goggles
  - ISO ‘standard’- 1.5 s open/2.0 s closed cycle until task completed
- Metrics:
  - Total-Shutter Open Time (TSOT)
  - Number of shutter openings
- Alternatives: self-paced, different cycle settings

STISIM + PDT

- Scenario: 20 to 30 minutes
  - 4-lane highway driving with straight and 2000'-radius curve sections
  - Car following at 55 mph
  - Improved realism for lateral control with ~ 5 sec Time to Line Crossing (TLC) to left or right;
  - Improved realism for accel and decel profiles
  - Improved steering and pedals
  - Run along with PDT lights
- PDT Lights
  - Red Laser light projected onto STISIM screen periodically on left shoulder ahead of A-pillar
  - Participant presses button when light detected
- Surrogate Metrics
  - STISIM: SDLP, SDHD, MEANHD
  - PDT: Detection Latency, Detection Rate

Subjective Assessments & Questionnaire Data

- Rated Subjective Workload
  - Trying new and conventional scaling techniques
  - Ratings done at end of entire experience (not after each task)

    to compare to prior literature in which ratings have been obtained after every task
- Rated Comfort/Confidence In Performing Tasks
  - Some similarity to scale that has proven useful in JAMA research
- Rated Willingness to Engage In Tasks
  - Developed new questionnaire in attempt to see if self-reports of willingness to engage reveal anything different
- Self-Reported Use of Advanced Info Systems (prior to study) (based on NHTSA inventory)
- Self-Rated Multitasking Ability

Task-Analytic Surrogates

- Analytic Surrogates to be assessed:
  - Heuristics: number of task steps
  - Modified MRT Model: interference potential
  - IVIS-DEMAND Model: predictions of performance
- Task-Analytic Surrogates do not involve testing of participants

Overview of DC/BMW-Project ADAM (Advanced Driver Attention Metrics)

DC/BMW-Project ADAM
(**A**dvanced **D**river **A**ttention **M**etrics)

- Start: 02/2002
- Objectives:
  - Special focus on direct measurement of driver distraction
  - Development of efficient and fast verification procedures

    Comparison of 5 methods:
    - Lane Change Test
    - Static Driving Simulator
    - Peripheral Detection Task
    - Combined Probe Test
    - Occlusion Method
  - Method Validation through field test and simulator studies






ADAM Peer Review Board

- Members
  - Dr. P. C. Cacciabue (EU Joint Research Centre, Institute for Systems, Informatics and Safety)
  - Dr. C. Gelau (BASt, Federal Highway Research Institute Germany)
  - A. Hallén (Volvo Cars)
  - Dr. R. van der Horst (TNO Human Factors)
  - Prof. Dr. A. Zimmer (Regensburg University, Institute of Psychology)
- Tasks:
  - invited to participate in experiments (“OpenLab”)
  - provide scientific comments/guidance on structure and results
  - disseminate ADAM content and idea

DC/BMW-Project ADAM
(**A**dvanced **D**river **A**ttention **M**etrics)

State-of-the art knowledge

- driver distraction in accident causation
- candidate assessment methods

Phase 1

Method Development

- Occlusion Method
- Peripheral Detection Task
- Probe Reaction Task
- Lane Change Test
- Static Driving Simulator (BMW)

Dynamic Driving Simulator (DC)

Phase 2

Method Validation

Static Driving Simulator Test

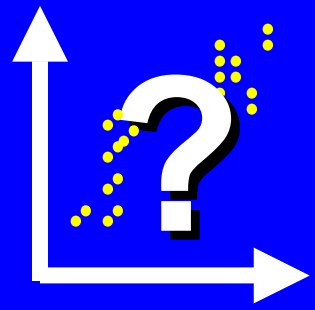
Laboratory Test (chosen method)

Field Tests(DC)

Phase 3

Assessment of Advanced In-Vehicle Systems

- Total Task Time
- Number of Glances
- Single Glance Duration
- Total Glance Time
- ...



Driver-system-interaction

visual glance behavior

Secondary task

Driving task

driver

manual interaction

visual feedback

system

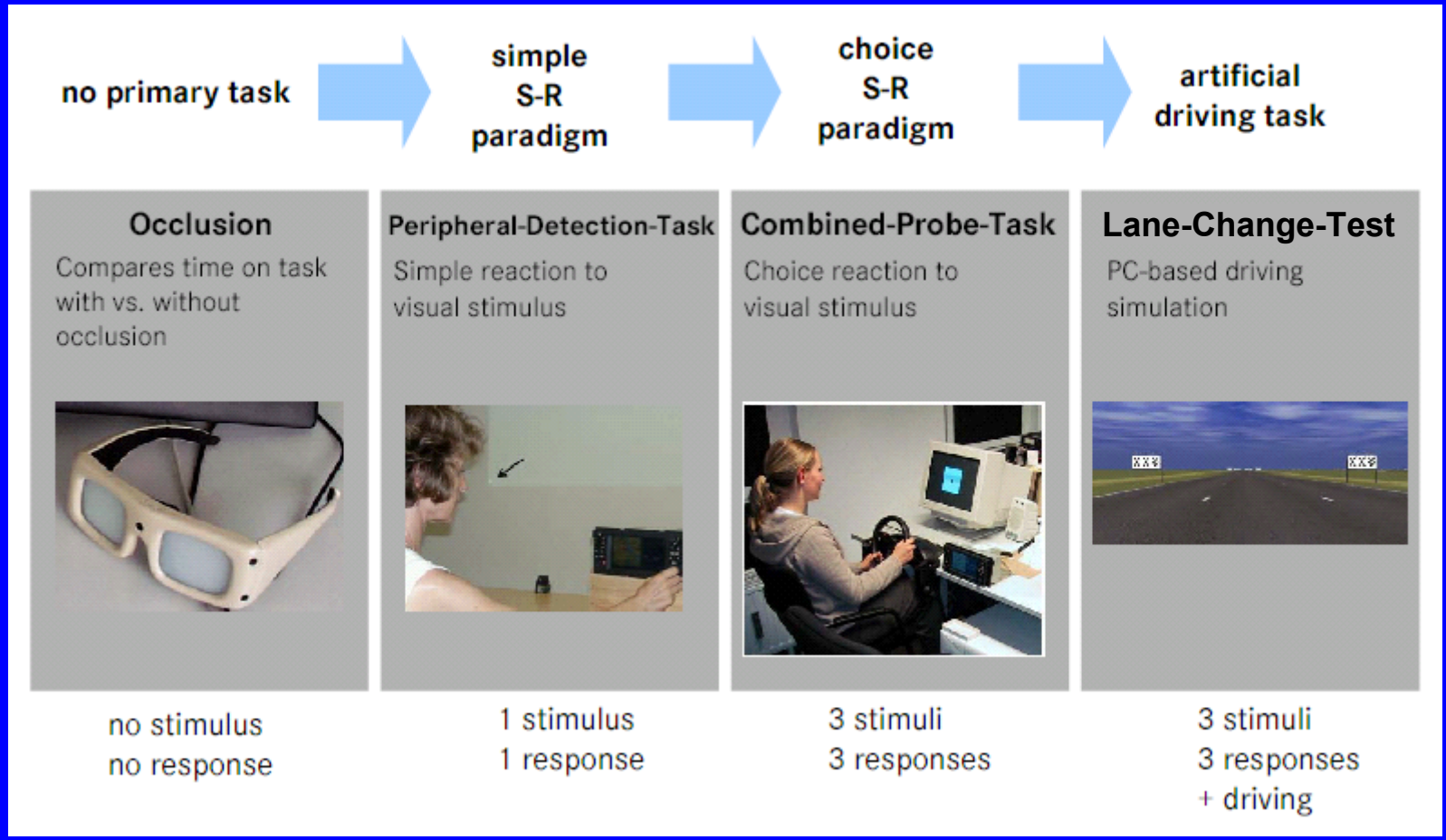
vehicle

- Time to Collision
- Following Distance
- Lane Exceedance
- ...

Driving performance

Verification Procedure

Candidate Surrogate Measures



Method evaluation with different tasks

- System integrated tasks
  - enter 12 digit telephone number
  - adjust sound (treble and bass)
  - enter destination using speller (5 + 4 letters)
  - enter town using cursor on digital map
  - change cassette

- Conventional tasks
  - unwrap kleenex
  - select 3 sweets of same color
  - unwrap chewing gum
  - determine next train from printed schedule

Project Status

- CAMP
  - Initial data analyses of driving performance measures are complete, except for eye glance data
  - Eye glance data are being reduced (from January through May 2004)
  - Findings will be reported by end of September 2004
- ADAM
  - Baseline experiment performed on public roads; Analysis of driving performance and eye glance behavior completed
  - 5 surrogate methods evaluated, validation of Lane Change Test and Occlusion Method finished with good results
  - Further optimization and elaboration of LCT and Occlusion until May 2004

Concluding Observations

- Both research projects provide empirical data on metrics and criteria which may be useful for enhancing the voluntary guidelines in the Alliance Driver Focus document
- The two projects illustrate the kind of cooperation within industry on a global basis – as well as the cooperation between industry and government - that can be achieved. It is a vital part of making progress toward successful management of driver workload as telematics products are deployed worldwide.

Alliance Guidelines – Commitment

Originally issued April 22, 2002 (v 2.0)
Re-Confirmed November 19, 2003 (v 2.1)

Statement of Principles, Criteria and Verification Procedures on Driver Interactions with Advanced In-Vehicle Information and Communication Systems

Draft Version 2.1

Driver Focus-Telematics Working Group

September 30, 2003

COMMITMENT OF THE
ALLIANCE OF AUTOMOBILE MANUFACTURERS
TO THE
STATEMENT OF PRINCIPLES, CRITERIA, AND
VERIFICATION PROCEDURES ON DRIVER INTERACTIONS WITH
ADVANCED IN-VEHICLE INFORMATION
AND COMMUNICATION SYSTEMS

…Alliance members will design future information and communication systems according to the recommendations of the guideline document. Members will begin these design efforts as soon as feasible. This will vary by company and by vehicle program. At the very latest, future systems designed according to these guidelines will be integrated into new vehicle programs with program initiation/design freeze dates occurring approximately 18 months after the issuance of these guidelines…

Signed by Josephine S. Cooper, Alliance President & CEO, on behalf of:

BMW Group	DaimlerChrysler Corporation
Fiat Auto S.p.A.	Ford Motor Company
General Motors Corporation	Isuzu Motors America, Inc.
Mazda North American Operations	Mitsubishi Motor sales of America, Inc.
Nissan North America, Inc.	Toyota Motor North America
Volkswagen of America, Inc.	Volvo Cars of North America, Inc.